Relative Growth Patterns of Two West Coast Squid (*Gonatus fabricii* and *Gonatopsis borealis*)

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(2 Text figures)

INTRODUCTION

The optimal method of determining patterns of growth in any organism is to maintain the species in a laboratory situation where measurements of size increases can be made throughout the lifetime of the individuals. For many organisms this task is quite impossible. Therefore measurements of relative growth are quite often used as substitutes.

Although relative growth patterns do not indicate the time taken to attain maximum size, they are useful to compare the growth of two different species of squid. Haefner (1964) utilized the differences in growth patterns to taxonomically differentiate between *Loligo pealei* and *Lolliguncula brevis* in Chesapeake Bay, Maryland. This study presents the differences in relative growth of *Gonatus fabricii* (Lichtenstein, 1818) and *Gonatopsis borealis* Sasaki, 1923, two pelagic squid species of the open ocean off Oregon.

METHODS

Eighty-one *Gonatus fabricii* and 88 *Gonatopsis borealis* were examined in detail. The specimens measured included those collected by the Department of Oceanography, Oregon State University and others loaned to the department by the U. S. Fish and Wildlife Service and the University of Washington (Pearcy, 1965). Eight morphological characteristics were measured (these are described by Haefner, 1964): mantle width (MW); head width (HW); head length (HL); nuchal cartilage length (NCL); fin width (FW); fin length (FL); siphon width (SW); and siphon length (SL).

The relative growth patterns were determined as follows:

1. The squid were grouped in 10 mm intervals of dorsal mantle length. The average measurement for each of the 8 characters was calculated and in turn divided by the average dorsal mantle length for that interval. The resultant figure is defined as the morphometric index.
2. The indices for each size interval were plotted against average dorsal mantle length and the points were connected. The resultant curve is defined as the growth pattern.

The curves for *Gonatus fabricii* are more accurate in the lower size range (15 - 60 mm) than in the higher size range (60 - 190 mm) because of a lack of larger individuals. Comparable numbers of *Gonatopsis borealis* were measured in each size interval.

RESULTS

Gonatopsis borealis

The relative growth patterns of *Gonatopsis borealis* are presented in Figure 1 (left). Two distinct patterns are readily discernible. One pattern is a rapid increase of the character size up to 30 mm mantle size followed by either a plateauing (FL) or a continued peaking and then decrease (FW). The other pattern is a relatively rapid decrease of the character changing at 30 mm mantle length to a less rapid decrease (MW, HW, HL, SW, SL, and NCL). Of the second group, mantle width exhibits the greatest decrease, whereas siphon length the least decrease, with the other characters intermediate. The less rapid decrease mentioned above is not a constant decrease as minor peaks are exhibited by head width at 40 mm, 60 mm, and 90 mm; head length at 50 mm; and nuchal cartilage at 90 mm.

[1] This work was done as a Graduate Student in the Department of Zoology, Oregon State University, Corvallis, Oregon 97331

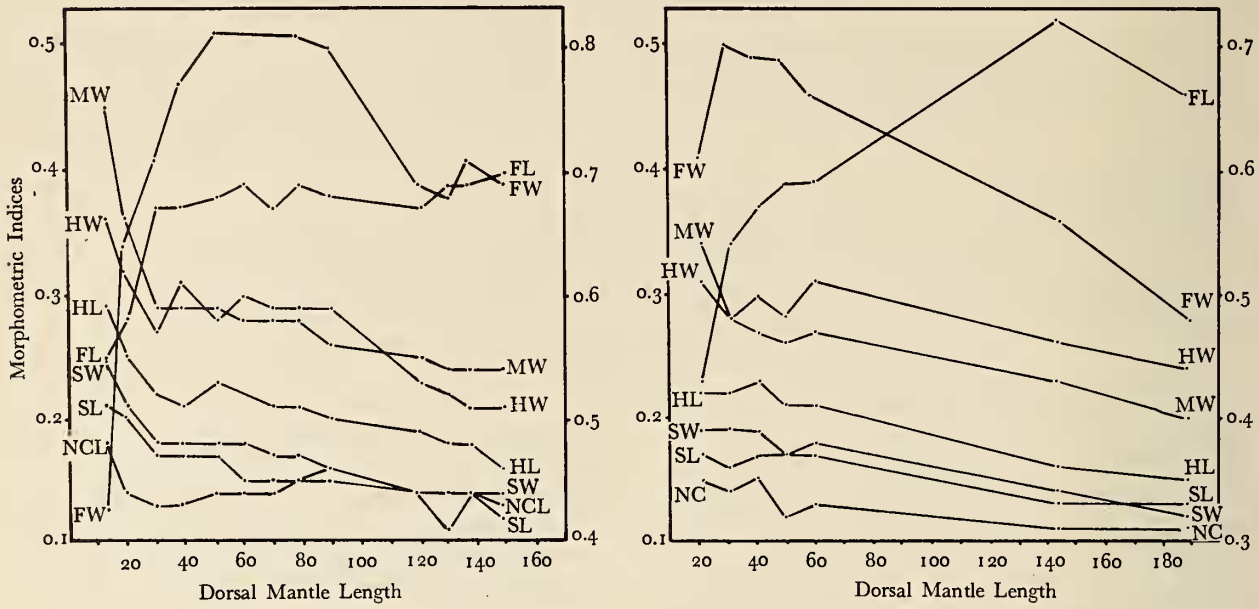

Figure 1

Relative growth patterns of *Gonatopsis borealis* (left) and *Gonatus fabricii* (right). The scales at the right of each are only for fin width indices

FL Fin Length	HL Head Length	MW Mantle Width	SL Siphon Length
FW Fin Width	HW Head Width	NCL Nuchal Cartilage Length	SW Siphon Width

Gonatus fabricii

The relative growth patterns of *Gonatus fabricii* are presented in Figure 1 (right). The two general patterns observed for *Gonatopsis borealis* are also discernible for this species. All morphological characters except fin length exhibit growth curves that end at values lower than those of their starting points. Most curves (MW, HW, HL, SW, SL, and NCL) between 20 to 60 mm mantle length show minor but progressively lower fluctuations. Fin width and fin length both show increases in the same interval, but the curve for fin length continues to rise attaining a peak at 143 mm, and then decreases, whereas the curve for fin width reaches a peak at 30 mm and decreases thereafter.

DISCUSSION

Generally speaking, with two exceptions, the growth patterns for *Gonatopsis borealis* and *Gonatus fabricii* are similar, showing higher values in the smaller squid and lower values in the larger squid. As the curves are of the relative growth patterns (i. e., growth with respect to the dorsal mantle length), this indicates that the mantle length increases at rates greater than those of the other measurements. As larval squid often have a truncated, broad mantle and the mantle length:width ratios increase with age, these patterns should be expected.

The two exceptions mentioned above are in fin width and fin length. Both *Gonatopsis borealis* and *Gonatus fabricii* show large increases in the rate of growth for fin length, but the rate of growth for the former reaches a plateau after peaking at 30 mm mantle length, whereas the growth of the fin length of the latter continues to rise, reaching a peak at 143 mm mantle length. In the rate of growth for fin width, *Gonatopsis borealis* exhibits rapid growth, peaking at 50 mm mantle length, remaining steady for another 40 mm of mantle length, then decreasing thereafter. The growth curve for fin width in *Gonatus fabricii* increases rapidly to a peak at 30 mm mantle length, but then decreases throughout the rest of the curve. The differences in fin morphology can be seen also in Figure 2.

I believe the above differences in the morphology of the fins are indicative of a functional difference between the two squid species. Williamson (1965) concluded from

observations made on *Illex illecebrosus* that the fins served to steer the squid and that, as the density of the squid exceeded that of the water, they may also have served to create a lifting force. Similar observations are mentioned by LANE (1960) and MORTON (1964). If the area of the fin is related to lift (i. e., the larger surface area provides greater lift when moving at slow speeds) then *Gonatopsis borealis* (fin area = 478 mm² for dorsal mantle length of 210 mm) would be more efficient than *Gonatus fabricii* (fin area = 306 mm² for a dorsal mantle length of 217 mm). The fin of *Gonatopsis borealis* is also stronger than that of *Gonatus fabricii,* if greater fin thickness is indicative of greater muscular strength. Non-quantified observations made during this study showed that there was a difference in the thickness of the fins of the two squid species.

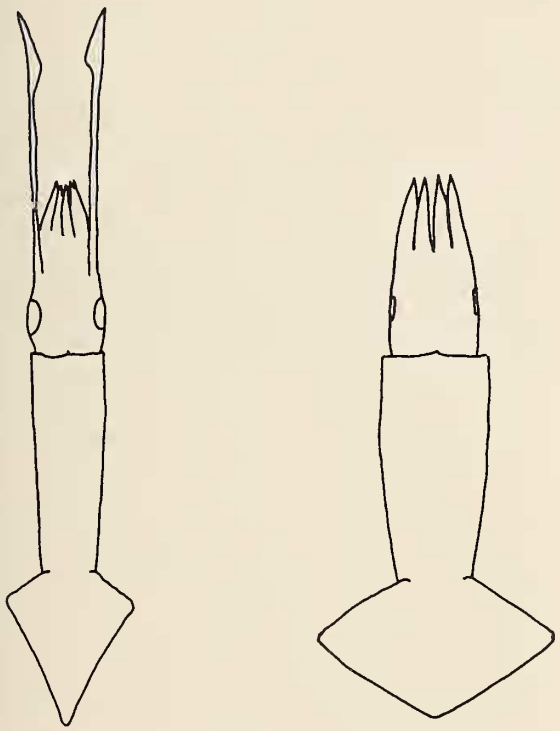

Figure 2

External morphology of *Gonatus fabricii* (left) (217 mm dorsal mantle length) and *Gonatopsis borealis* (right) (210 mm dorsal mantle length)

From the differences shown by the relative growth patterns and by the gross external differences it appears that the fins of *Gonatopsis borealis* play a much greater role in the maintenance of vertical position and in locomotion at slow speeds than do those of *Gonatus fabricii.* Although both squids are good swimmers, the former should be more active than the latter in maintaining its vertical position.

The relative growth patterns obtained in this study are very similar to those calculated by HAEFNER (1964). HAEFNER used the information from his morphometric study as a means of taxonomically differentiating between *Loligo pealei* and *Lolliguncula brevis.* He noted that the main difference in the growth patterns of the two species was in the fin width and length indices. Although he did not reach any conclusions concerning the locomotion of the two species, it seems as if functional differences hypothesized in this study might also be applicable there.

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LITERATURE CITED

HAEFNER, PAUL A., Jr.
1964. Morphometry of the common Atlantic squid *Loligo pealei,* and the brief squid, *Lolliguncula brevis,* in Delaware Bay. Chesapeake Sci. 5: 138 - 144

LANE, FRANK WALTER
1960. Kingdom of the Octopus. Sheridan House, New York, N. Y.; 432 pp.

MORTON, JOHN EDWARD
1958. Molluscs: An introduction to their form and functions. New York, Harper Bros. 232 pp.; 23 text figs.

PEARCY, WILLIAM GORDON
1965. Species composition and distribution of pelagic cephalopods from the Pacific Ocean off Oregon. Pacif. Sci. 14: 261 - 266

WILLIAMSON, G. R.
1965. Underwater observations of the squid *Illex illecebrosus* LESUEUR in Newfoundland waters. Canad. Field-Natur. 79: 239 - 246